Gender difference and age-related changes in performance at the long distance duathlon world championship

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GENDER DIFFERENCE AND AGE-RELATED CHANGES IN PERFORMANCE AT THE LONG DISTANCE DUATHLON WORLD CHAMPIONSHIPS

Performance in duathlon

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ABSTRACT

The differences in gender and the age-related changes in triathlon (*i.e.* swimming, cycling, and running) performances have been previously investigated, but data are missing for duathlon (*i.e.* running, cycling, and running). We investigated the participation and performance trends, as well as the gender difference and the age-related decline in performance, at the 'Powerman Zofingen' long-distance duathlon (10km run, 150km cycle, and 30km run) from 2002 to 2011. During this period, there were 2,236 finishers (272 females and 1,964 males, respectively). Linear regression analyses for the three split times, and the total event time, demonstrated that running and cycling times were fairly stable during the last decade for both male and female elite duathletes. The top ten overall gender differences in times were 16±2 %, 17±3 %, 15±3 % and 16±5 %, for the 10km run, 150km cycle, 30km run and the overall race time, respectively. There was a significant ($p < 0.001$) age effect for each discipline, and for the total race time. The fastest overall race times were achieved between 25 and 39 years old. Female gender and increasing age were associated with increased performance times when additionally controlled for environmental temperatures and race year. There was only a marginal time period effect ranging between 1.3% (first run) and 9.8% (bike split) with 3.3% for overall race time. In accordance with previous observations in triathlons, the age-related decline in the duathlon performance was more pronounced in running than in cycling. Athletes and coaches can use these findings to plan the career in long-distance duathletes with the age of peak performance between 25 and 39 years for both females and males.

KEY WORDS running – cycling – gender difference – aging – ultra-endurance

INTRODUCTION

In recent years, an interest in investigating the participation and performance trends in endurance events such as long distance running (7, 8, 17,19) and multi-sport events (*e.g.* triathlon) has increased considerably (12, 18, 22). The changes in triathlon performances over the years have been examined in traditional (*i.e.* swimming, cycling and running), long-distance and ultra-distance triathlons (12, 18), as well as off-road (*i.e.* swimming, mountain biking and trail running) triathlons (22, 23). These studies showed that after a period of improving performances in the years following the first race, a stabilisation then generally occurred. However, the findings differed slightly between gender and distance.

The sports discipline duathlon (*i.e.* running, cycling, and running) is apart from triathlon another multi-sport discipline that is officially refereed by the International Triathlon Union (ITU) (www.triathlon.org/multisports/duathlon). To date, duathlons have received little attention from scientists (30, 33), and no study has investigated their participation and performance trends. The 'Ironman Hawaii' (http://ironman.com/worldchampionship) is the most prestigious Ironman triathlon in the world, and tens of thousands of triathletes try to qualify for it each year (18, 20). While the 'Ironman' triathlon races series actually offers more than 25 races around the world to qualify for the 'Ironman Hawaii' (http://ironman.com), the long-distance duathlon race series 'Powerman' offers currently only nine races around the world (www.powerman.org). Similar to the 'Ironman Hawaii', the 'Powerman Zofingen' duathlon (www.powerman.ch), held in Switzerland, is one of the most famous long-distance duathlons in the world. In the last years, the 'Powerman Zofingen' was held as the 'ITU Powerman Long Distance Duathlon World Championships'.

The age and gender interactions (20, 31), and the age and locomotion mode interactions (1, 23, 24), in triathlon performances have previously been investigated in both the Olympic (short distance) and Ironman (long distance) distances. It appears that the age-related performance decline is greater in females compared with males, and is specific to the locomotion mode. Indeed, it has been shown that the reduction in performance with advancing age was less pronounced in cycling compared with swimming and running (1, 23, 24). In addition, the age-related performance decline in cycling and running performances appears greater over the longer distances when compared with short distance triathlons, suggesting that the duration of exercise exerts an important influence on the magnitude of the age-related changes (24). A duathlon comprises only two disciplines but like triathlon it also includes three legs, the first and third leg being running, with cycling in the middle. The first leg of a duathlon, consisting of a prolonged running exercise, may induce significant muscle fatigue (21) which could affect subsequent cycling and running performances to a greater extent when compared with a triathlon.

The gender differences in overall triathlon performances varied between ~15 % and ~30 %, according to the distance and the type of triathlon (12, 18, 20, 22). Regarding the split disciplines, the gender differences are comprised between 15 % and 23 % for cycling and between 18 % and 32 % for running, respectively (12, 18, 20, 22). Because skeletal muscle mass differs between male and female triathletes (10, 11, 16), muscle fatigue might also differ between the genders. Therefore, it might be interesting to examine whether there is a gender difference between running and cycling in a duathlon, and also between the first and second run split.

The aims of the present study were (*i*) to analyse the participation and performance trends of both males and females at the 'Powerman Zofingen' duathlon from 2002 to 2011, (*ii*) to examine gender differences in running, cycling and total times in elite duathletes, and (*iii*) to analyse the age-related decline in running, cycling and total duathlon performances.

METHODS

Experimental Approach to the Problem

The 'Powerman Zofingen' is one of the oldest and best known long-distance duathlons in the world (www.powerman.ch) and is now held as the official 'ITU Powerman Long Distance Duathlon World Championships' (www.powerman.org). The race has existed since 1989, and the race course has been changed several times. However, since 2002, it has remained unchanged, and consists of a 10km run, a 150km cycle and a 30km run. In contrast to the 'Ironman Hawaii', where the field of starters is limited and the athletes have to qualify for the race, there is no limitation to the number of athletes that can take part in the 'Powerman Zofingen'.

Subjects

Subjects were all finishers (272 females and 1,964 males) of the 'ITU Powerman Long Distance Duathlon World Championships' from 2002 to 2011. The data set from this study was obtained from the race website and the Race Director. The study was approved by the Institutional Review Board of St. Gallen, Switzerland, with a waiver for the requirement of an informed consent, given that the study involved the analysis of publicly available data. The age at the time of competition, as well as the running, cycling and total time performances of both female and male finishers at the 'Powerman Zofingen' were analysed from 2002 to 2011. Firstly, the age at the time of competition and the 10km run, 150km cycle, 30km run and total time performances of the top ten elite male and female finishers overall were analysed from 2002 to 2011. Secondly, because female data were limited, we focused on the run, cycle, and total time performances of the top five males in ten age groups over the same period. Each age group covers a period of five years as follows: 20-24 years, 25-29 years, 30-34 years, 35-

39 years, 40-44 years, 45-49 years, 50-54 years, 55-59 years, 60-64 years, and 65-69 years, respectively.

Procedures

Data (*i.e.* age, running, cycling, and total performance times) were averaged over the first ten male and female finishers in each year from 2002 to 2011, and the running, cycling, and total performance times were converted to minutes. The spread of the top ten elite times, *i.e*. the time difference between the winner and the tenth, was also analysed and expressed as a percentage of the winner's time, for both sexes, over the same period. The magnitude of the gender difference was examined by calculating the percent difference in the running, cycling, and total times of the top ten males versus females. The one-way ANOVA showed that there was no statistical difference in the total performance times of the top five males in each age group in our studied years, so we pooled nine years of data. Therefore, we considered only the performances of the best 20 male duathletes in each age group over this period in order to analyse the age-related changes. The 10km run, the 150km cycle, the 30km run and the overall times of the 20 best male duathletes in each age group were then normalised to the mean time of the best performing age group. Thus, the age-related declines in performance were expressed using a ratio calculated between the individual and the mean time performances of the best performing age group in each discipline, plus the overall race time (24). The local temperature at the start and at noon as well as general weather conditions were provided by www.meteoschweiz.ch (see **Table 1**).

Statistical Analyses

Data are reported as means ± SD in the text and displayed as means ± SE in the figures. Linear regressions were used for estimating the changes of selected variables each year.

Pearson's correlation coefficients were used to assess the association between differing variables (Statsoft, Version 6.1, Statistica, Tulsa, OK, USA). To determine whether the overall race time of the top ten male and female finishers differed over the years, a two-way ANOVA was performed. One-way ANOVA was used to compare the running, cycling and overall race times between the different age groups. A two-way ANOVA was used to compare the performance ratios between the 10-km run, the 150-km cycle and the 30-km run over this period. Tukey's post hoc analyses were used to test differences within the ANOVA when appropriate. Statistical significance was accepted at $p < 0.05$. The associations between performance (total, and three split times, *i.e.* first run, cycling, second run) and athletes characteristics (*i.e.* age, gender) taking into account environmental factors (*i.e.* morning- and noon temperatures) were further investigated. To account for potential clustering between time periods, we performed multilevel (hierarchical) regression analysis including race year as cluster variable. We calculated Intraclass Correlation Coefficients (ICCs) to estimate the variance that can be explained on the cluster level (*i.e.* race year). ICCs were calculated as follows: (variance of the performance time/total variance) x100. Statistical significance was accepted at a two-sided $p < 0.05$.

RESULTS

From 2002 to 2011, there were 2,236 finishers (272 females and 1,964 males, respectively) at the 'Powerman Zofingen'. The number of finishers each year over the history of the event is shown in **Figure 1A**, ranging from 162 to 267 males and from 17 to 47 females, respectively. Females accounted, on average, for 12±3 % of the field. The age distribution of the male finishers during this period is displayed in **Figure 1B**. The 5-year age brackets with the largest participation have been 30-34 years and 35-39 years. Non-finishers represented 14±3 % of the starters field for the male and 12±5 % for the female, respectively. The rate of non-finishers did not significantly change across the years.

The ANOVA shows that the total time performance of the top ten males and females did not differ over the years, and **Figure 2** shows the historical performance trends of this group. Regression lines for the three split times and the total event time demonstrated that both the running and cycling times were fairly stable from 2002, for both genders. The mean age, and the 10km running, 150km cycling, 30km running and total performance times for the top ten of both sexes, over the last decade, are given in **Table 2**. From 2002 to 2011, the average differences in time between the winners and the tenth-placed finishers remained stable and was equal to 7.5±1.6 % for males and 15.4±5.2 % for females, respectively. The average differences between the top ten male and female running, cycling, and overall race times were consistent at ~18-19 % (see **Table 2**).

The mean age-related changes in running, cycling, and overall race times from 2002 to 2011 are shown in **Figure 3**. The times of the three splits, and the overall race time, increased in a curvilinear manner with advancing age. There was a significant ($p < 0.0001$) age effect for each discipline and for the total time. The best 10km run, 150km cycle and total time was found in the age groups 25-29 years, 30-34 years and 35-39 years and no differences in times were observed between these three age groups. For the 30km run, the times of the 40-44 year group were similar to that of the three younger age groups.

The performance ratios for each mode of locomotion decreased in a curvilinear manner with advancing age (see **Figure 4**). There was a significant interaction between age and the disciplines in the performance ratio (F = 6.9, $p < 0.001$), and these ratios also differed between the locomotion modes (F = 68.9, $p < 0.0001$). Independent of the age, the ratios were significantly different ($p < 0.001$) between each of the three disciplines (10km run, 150km cycle and 30km run). In addition, independent of the discipline, the performance ratio differed between the age groups (F = 161.8, $p < 0.001$), and was significantly lower ($p < 0.01$) for the age groups 40-44 years and above when compared with the age groups 25-29 years and 30-34 years.

Results of the multilevel regression analysis not restricted to the top ten athletes are displayed in **Table 3**. Female gender and increasing age remained significantly associated with increased performance times when additionally controlled for environmental factors (*i.e.* morning- and noon temperature) and taking into account a potential clustering due to the time period (*i.e.* race year). An increased noon temperature was associated with an increased split time for cycling. Corresponding ICCs for race year as cluster variable on performance were as follow: 3 % for total race performance and for the split time first run, 10 % for the split time cycling, and 1% for the split time second run. Therefore, 3 % of the total performance variance can be explained on the race-year level, or in other words the correlation between two athletes in the same year is only 0.03.

DISCUSSION

The aim of the present study was to analyse the participation and performance trends, as well as the gender differences and the age-related decline in running, cycling and total long distance duathlon performances during the last decade. The effects of environmental conditions such as temperature on performance were also investigated.

Regarding the participation in the 'Powerman Zofingen', after a peak in 2003, the number of male finishers remained stable for five years and then slightly increased these last three years. The number of female finishers remained quite stable from 2002 to 2008, with a small increase in 2009 and 2011. These data relating to a long- distance duathlon differ from those of other endurance events such as ultra-endurance running. For example, Hoffman *et al.* (8) analysed the participation trends in 161km ultra-marathons, in North America, from 1977 to 2008 with a total of 32,352 finishers. The annual number of races, and the number of finishers, increased exponentially over this time frame. Knechtle *et al.* (12) analysed the participation and performance trends in ultra-triathlons from 1985 to 2009. The number of starters in a Double Iron ultra-triathlon (*i.e.* 7.8km swim, 360km cycle and 84.4km run), a Triple Iron ultra-triathlon (*i.e.* 11.4km swim, 540km cycle and 126.6km run) and a Deca Iron ultra-triathlon (*i.e.* 38km swim, 1,800km cycle and 420km run) increased progressively from 1985 to 2009. In both the 161-km ultra-marathons (7-9) and the ultra-triathlons (12) there were no limits to the number of participants. Similarly, at the 'Powerman Zofingen' there was no participation limit, in contrast to the 'Ironman Hawaii' (18) where triathletes need to qualify. So, the unchanged participation level in the 'Powerman Zofingen' was presumably not due to a limit set by the organiser, but rather due to other factors.

We assume that duathlon is less attractive than triathlon because, firstly, in contrast to triathlon it is not an Olympic discipline and, secondly, there is less media coverage given to duathlon races. For example, the swim start of triathlon is more spectacular and attractive to spectators compared to the first run leg of duathlon. To date, no study has investigated the participation trends in Ironman triathlons. However, considering the fact that more than 25 Ironman races are offered around the world, in order to qualify for the 'Ironman Hawaii' (http://ironman.com/events), one must assume that a kind of 'market force' affects the demand. For example in 2011, 11 Ironman races are offered in North America, eight in Europe, three in Australia and New Zealand, two in Asia, one in South America, and one in Africa. In the long-distance duathlon race series, the 'Powerman' offers only nine races each year (www.powerman.org). In 2011, those offered six races in Europe, two races in the USA, and one race in Asia. Presumably, the large number of Ironman races on offer makes it more attractive to multi-sport athletes compared with Powerman duathlons.

Regarding the performances of the male and female elite duathletes, there were no changes in the cycling, running and total times since 2002. In contrast, it has been shown that at the 'Ironman Hawaii' the performance times of the male and female elite triathletes decreased during the 1980s and then tended to stabilise over the last two decades (18). Elite duathletes racing in the 'Powerman Zofingen' are experienced multi-sport athletes and this could explain the relative stability of performance over this period. In addition, some experienced triathletes may have moved from triathlon to duathlon because of their relative weakness in swimming compared with running and cycling. The observed gender differences in performances should not arise from motivation regarding prize money as the total prize money of 50,000 US Dollars is distributed equally between the top male and female athletes. The gender difference in running, cycling, and total event time was consistent ~18-19% in long-distance elite duathletes. These findings are in accordance with previous values observed in off-road (23) and Ironman triathlons (18).

The gender difference for the overall performance might be explained by anthropometric and physiological differences for these multi-sports athletes as has been reported for Ironman triathletes competing in swimming, cycling and running. For example, Knechtle *et al.* (13) showed that female triathletes with 28.0 kg skeletal muscle mass have a 32 % lower muscle mass compared to male triathletes with 41.0 kg. The lower skeletal muscle mass in female triathletes might be responsible for the 14 % lower maximum oxygen uptake (VO_2max) in female triathletes (52.8 ml · min^{-1} · kg^{-1}) compared to male triathletes (61.3 ml · min^{-1} · kg^{-1}) (11). Since VO_2max is related to triathlon performance (26), the lower VO_2max in females might explain the gender difference for overall race time. Also, percent body fat is related to performance in long-distance triathlon in male Ironman triathletes (13, 14). Male Ironman triathletes with 13.7 % body fat have a 42 % lower body fat compared to female Ironman triathletes with 23.6 % (13). The eccentric component of the first run leg may affect differently skeletal muscle damage in males and females and therefore impair, to a greater or lesser extent, the cycle and second run performance. For example, the impairment of performance might be greater in females compared with males because of their lower skeletal muscle mass (10, 11, 16). However, this assumption has not been verified because the gender difference was very similar between the first and the second run (~19 %) suggesting that the fatigue induced during the first run was similar for both genders.

Considering the age-related changes in duathlon performances, the present results showed that the best age to perform a long-distance duathlon was between 25 and 39 years. In the 30-km run athletes up to the age of 44 years were still competitive. The age-related changes differed between the three disciplines but the decline was less in cycling compared to either the 10km or the 30km run. The lower age-related decline in cycling compared with running performance observed for duathlon confirms recent findings on triathlon (1, 23, 24). Several hypotheses have been proposed in order to explain this finding, such as different mechanical powers required by the two disciplines, changes in muscle characteristics with age, lesser reduction in lactate threshold and/or economy in cycling compared with running, or the maintenance of a greater 'training stimulus' in cycling, with advancing age (24).

Lepers *et al.* (24) showed that after 55 years of age there was a lesser age-related decline in cycling performance compared with running in Olympic distance triathletes, and after 50 years in Ironman triathletes. Similarly, Bernard *et al.* (1) investigated the age-related changes in performance in Olympic distance triathletes and found that the decline in performance was more pronounced in running compared with cycling after 55 years of age. In cycling, the age-related decline in performance was not significant until the age of 55 years and was less than 3 % per year until the age of 60 years. The present results suggest that the age-related decline in performance appears earlier in duathletes (~40 years) compared with triathletes (~45-50 years). A combination of a reduced skeletal muscle mass with increasing age, and an increased skeletal muscle damage after the eccentric component of the first run leg, might explain this finding. However, a comparison of duathlon and triathlon performances in the same subjects would be necessary to validate this hypothesis.

In these duathletes, the age of peak performance was between 25 and 39 years for both females and males. In 1988, Schulz and Curnow (29) reported data from analyses of Olympic track and field and swimming data showing that for both females and males, the age of peak performance increased with the length of the foot race, where females generally achieved peak performance at younger ages. The pattern of increased age with increasing distance is reversed for female swimmers, where younger ages are associated with increasing distance. In a recent study on ultra-marathoners, Knechtle *et al.* (17) demonstrated that the best 100km running times was observed for the age comprised between 30 and 49 years for males, and between 30 and 54 years for females, respectively. We assume that the age of peak performance in ultra-distances increases with increasing length. Most probably, females are able to achieve peak performance in ultra-endurance races at a higher age compared to males. Future studies are needed to verify this assumption.

An important finding was that both female gender and increasing age were associated with increasing race performance times when controlled for temperature and race year. Recent studies showed that weather showed an effect of performance in marathoners (3, 4, 25, 32, 34) and ultra-marathoners (27, 35). The effect of weather was ambiguous in marathoners regarding the runners' ability. Vihma (34) reported that marathon race results of slower runners were more affected by unfavourable weather conditions. Ely *et al.* (4), however, demonstrated that increasing air temperatures slowed running pace more in faster marathoners than in slower marathoners. For ultra-marathoners, Parise and Hoffman (27) showed that extreme heat impaired all runners' ability to perform in a 161-km ultra-marathon where raster runners were at a greater disadvantage compared to slower runners. Wegelin and Hoffman (35) reported that advancing age and warmer weather impaired performance in 161-km ultra-marathoners. Regarding these findings for ultra-marathoners, we expected to find similarities for these long-distance triathletes. However, we found only an independent temperature effect on athlete's cycling performance, but not on overall performance. Presumably, the temperatures at Zofingen were rather moderate compared to the temperatures at the 'Western States Endurance Run' where the temperature was generally higher than 30°C (27).
Female gender was associated with slower race times in the duathletes when controlled for environmental temperatures. Recent studies showed equivocal findings regarding the

association of gender and performance regarding environmental temperatures for marathoners. Ely *et al.* (3) found no gender difference for marathon race times with increasing temperatures. Vihma (34), however, showed that effects of warm weather were less evident for females than for males and assumed that female runners' larger ratio of surface area to body mass and slower running speed were responsible for their findings. The effect of environmental temperature seems to be different for females in ultra-endurance performances. For ultra-marathoners, Wegelin and Hoffman (35) reported that warmer weather had similar effects of finish rates for males and females. However, finish times were slower with advancing age, slower for females than males, and less affected by warm weather for females than for males. The longer duration in an ultra-endurance performance seems to have different effects on race outcome regarding a marathon.

Also, we found only a marginal time period effect with ICCs ranging between 1% and 10%. For overall race time, 3% of the total performance variance can be explained on the race-year level. Or expressed in other words, the correlation between two athletes in the same year was only 0.03. These athletes showed no improvement in performance across the last years in the 'ITU Powerman Long Distance Duathlon World Championships' as it has been reported for other ultra-endurance races such as the Hawaii Iroman triathlon (18) or the 'Western States Endurance Run' (7-9). Generally, we would expect an improvement in performance due to improvements in technical equipment (6), training (5) or sports nutrition (2, 28). Most probably, the top ten athletes competing at a World Championship were at the top of their performance and they seemed to have reached their limits in performance.

This study is limited that we have no variables of training (5, 15) and anthropometry (13-15) included in this data analysis. Duathletes are multi-sport athletes such as triathletes and we assume that they are similar to triathletes regarding their anthropometry and pre-race preparation.

PRACTICAL APPLICATIONS

The performances in the 'ITU Powerman Long Distance Duathlon World Championships' remained stable in elite duathletes from 2002 to 2011. The gender differences in running, cycling, and total event time were consistent ~18-19 % in the elite duathletes, and did not differ between the first and the second run leg. As previous observations on triathlons showed, the age-related decline in performance was more pronounced in running than in cycling. Female gender and increasing age were associated with increasing race performance times when controlled for temperature and race year. Future studies should compare duathlon and triathlon performances, involving the same subjects, in order to investigate the possible differences in age-related changes in performance between these two long-duration multi-sport events. Athletes and coaches can use these present findings to plan the career in long-distance duathletes with the age of peak performance between 25 and 39 years.

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Year	Temperature morning	Temperature noon	General weather conditions
2002	14 °C	20 °C	Dry, blue sky
2003	8 °C	20 °C	Variable, showers
2004	12 °C	18°C	Rain
2005	13 °C	17 °C	Rain
2006	11 °C	13 °C	Rain
2007	14 °C	30 °C	Blue sky
2008	12 °C	21 °C	Blue sky
2009	8 °C	23 °C	Blue sky
2010	12 °C	24 °C	Blue sky
2011	11 °C	17 °C	Rain

Table 1: Temperature and general weather conditions at the ‘Powerman Zofingen’ from 2002 to 2011

	Age (years)	Total event (min)	10km run (min)	150km cycle (min)	30km run (min)
Male	32.2±2.0	403.3±14.6	31.9±0.6	247.1±12.0	124.0±3.2
Female	32.3±2.7	477.5±16.5	38.2±1.1	292.3±13.9	146.6±4.4
Gender difference		18.4±2.1 %	19.9±2.9 %	18.3±1.4 %	18.3±3.7 %

Table 2: Age, total event, 10km running, 150km cycling, and 30km running performance times for the top ten males and top ten females at the 'Powerman Zofingen'. Gender difference is expressed as a percentage of the male values and calculated for the top ten. Data were averaged from 2002 to 2011. Values are mean ± SD.

Overall race time (*n*=2,236)	**ß**	**P**	**95 % Conf. Intervall**	
Females	-39.3	0.000	-45.8	-32.9
Age (years)	2.5	0.000	2.3	2.8
Temperature morning (°C)	0.4	0.798	-2.7	3.5
Temperature noon (°C)	-1.2	0.102	-2.6	0.2
Split time first run (*n*=2,236)				
Females	-3.9	0.000	-4.4	-3.3
Age (years)	0.2	0.000	0.2	0.3
Temperature morning (°C)	-0.02	0.833	-0.3	0.2
Temperature noon (°C)	-0.006	0.924	-1.2	0.1
Split time cycling (*n*=2,236)				
Females	-28.1	0.000	-31.4	-24.8
Age (years)	1.3	0.000	1.1	1.4
Temperature morning (°C)	-0.2	0.894	-2.9	2.5
Temperature noon (°C)	-1.5	0.017	-2.8	-0.3
Split time second run (*n*=2,236)				
Females	-7.3	0.000	-10.4	-4.2
Age (years)	1.0	0.000	0.9	1.1
Temperature morning (°C)	0.6	0.275	-0.5	1.6
Temperature noon (°C)	0.2	0.347	-0.2	0.7

Table 3: Results of the multilevel (hierarchical) regression analysis showing the effects of athletes characteristics and temperature on overall race time and the split times including race year as cluster variable.

Figure legends

Figure 1

Number of female and male finishers at the 'Powerman Zofingen' from 2002 to 2011 (**Panel A**). Averaged age distribution of male finishers from 2002 to 2011 (**Panel B**).

Figure 2

Mean running (10 km), cycling (150 km), running (30 km), and overall race times in the 'Powerman Zofingen' of the top ten males (black circles) and females (white circles) from 2002 to 2011. Values are mean ± SE. The solid lines represent the linear regressions between 2002 and 2011.

Figure 3

Age-related changes in running (10 km and 30 km), cycling (150 km) and total male performances at the 'Powerman Zofingen' (means ± SE). 2002 to 2011 pool data (n=20 for each age group).

a : $p < 0.01$, significantly different from age group 25-29 years only.

b : $p < 0.01$, significantly different from age groups 25-29 years and 30-34 years.

c : $p < 0.01$, significantly different from age groups 25-29 years, 30-34 years and 35-39 years.

Figure 4

Age-related declines in running, cycling, and total performances at the 'Powerman Zofingen' (mean ± SE). 2002 to 2011 pool data (n=20 for each age group).

*: $p < 0.05$; ** : $p < 0.01$: Significantly different from 30-km running for the same age group.

$: $p < 0.05$; $$: $p < 0.01$: Significantly different from 10-km running for the same age group.

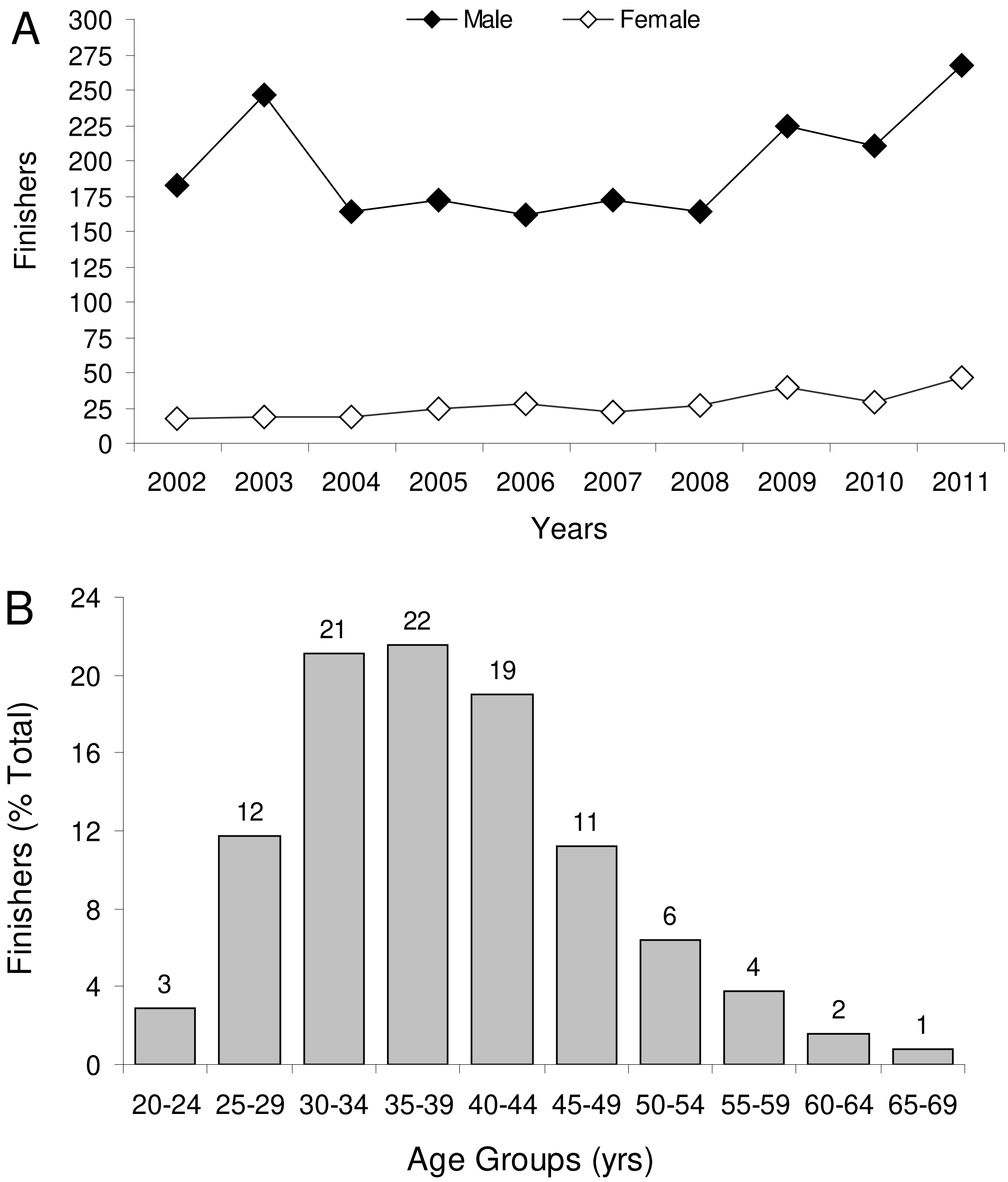
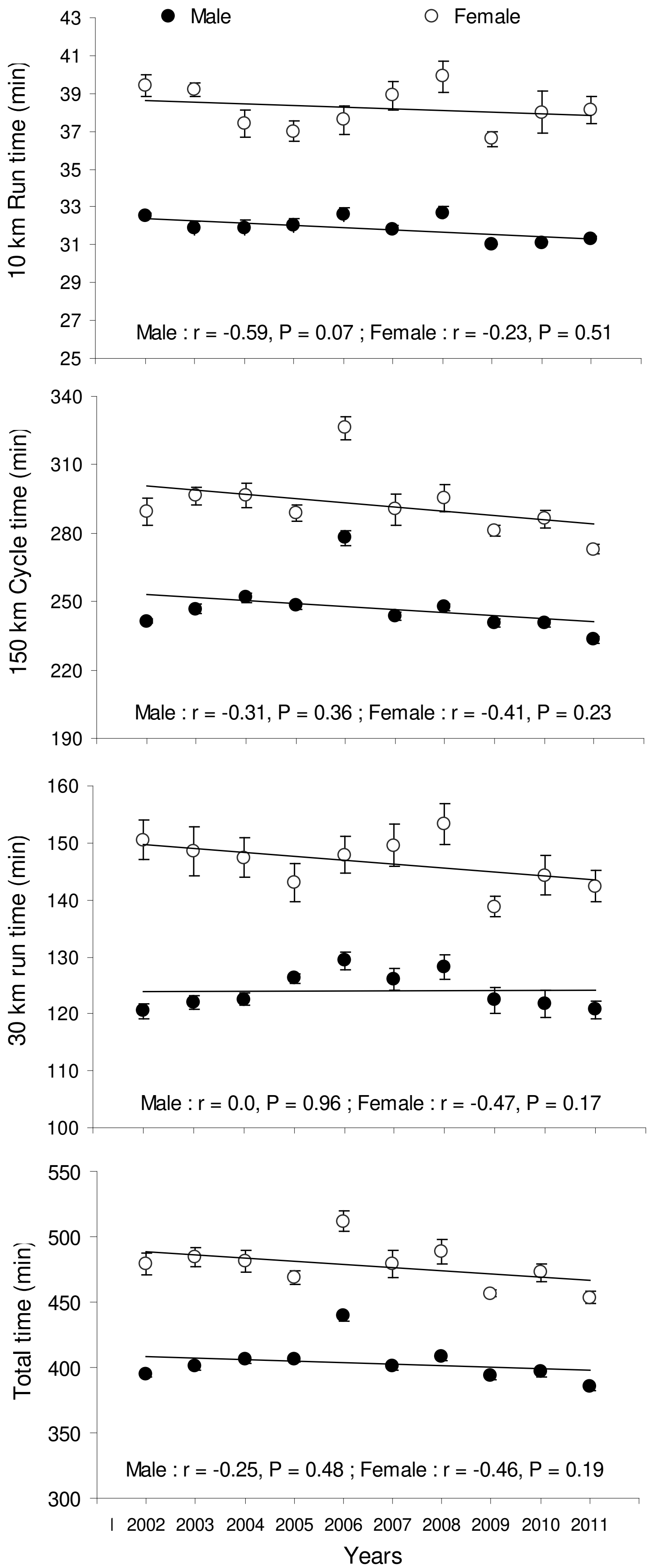
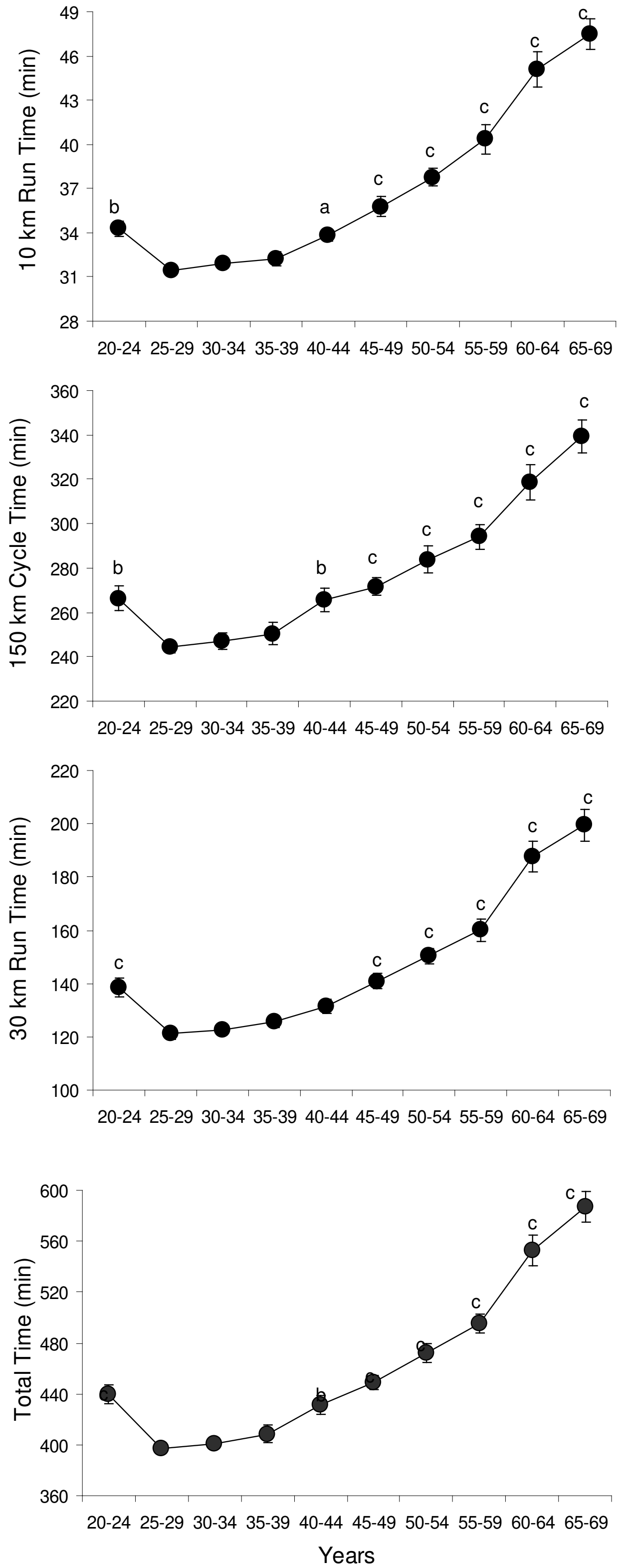

A
Male
Female
Finishers
300
275
250
225
200
175
150
125
100
75
50
25
0
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
Years
B
Finishers (% Total)
24
20
16
12
8
4
0
3
12
21
22
19
11
6
4
2
1
20-24
25-29
30-34
35-39
40-44
45-49
50-54
55-59
60-64
65-69
Age Groups (yrs)

Figure 1



Male
Female
10 km Run time (min)
Male : r = -0.59, P = 0.07 ; Female : r = -0.23, P = 0.51
150 km Cycle time (min)
Male : r = -0.31, P = 0.36 ; Female : r = -0.41, P = 0.23
30 km run time (min)
Male : r = 0.0, P = 0.96 ; Female : r = -0.47, P = 0.17
Total time (min)
Male : r = -0.25, P = 0.48 ; Female : r = -0.46, P = 0.19
2002 2003 2004 2005 2006 2007 2008 2009 2010 2011
Years

Figure 2



10 km Run Time (min)
150 km Cycle Time (min)
30 km Run Time (min)
Total Time (min)
20-24 25-29 30-34 35-39 40-44 45-49 50-54 55-59 60-64 65-69
Years

Figure 3

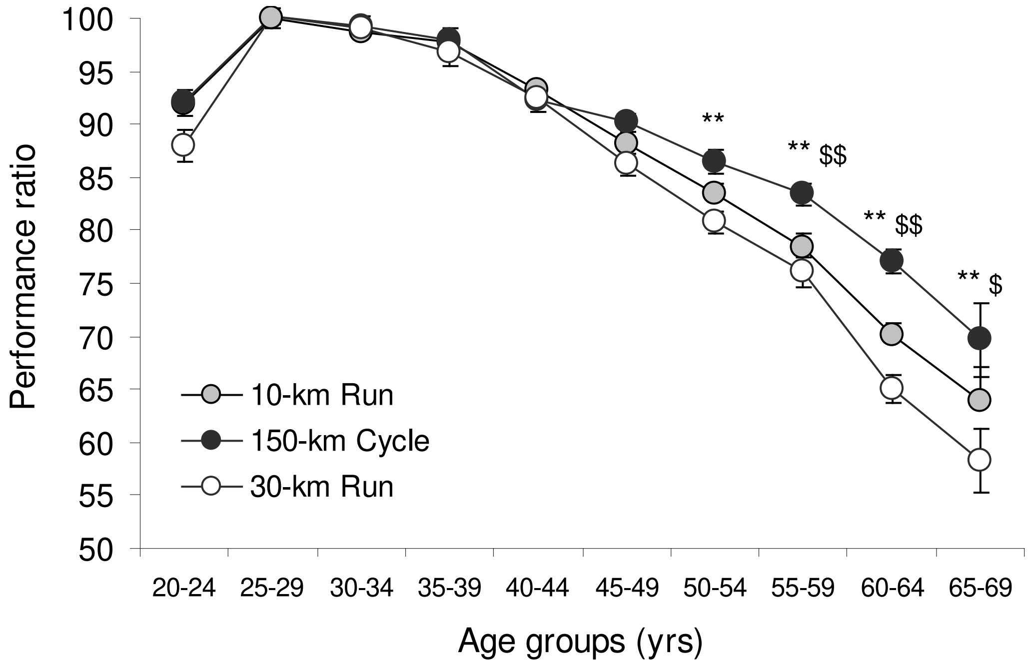

100
95
90
85
80
75
70
65
60
55
50
Performance ratio
**
** $$
** $$
** $
10-km Run
150-km Cycle
30-km Run
20-24
25-29
30-34
35-39
40-44
45-49
50-54
55-59
60-64
65-69
Age groups (yrs)

Figure 4